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prepared for central and western Asia from wholly different data. The substantial agreement of the two curves leads to the conclusion that in similar latitudes of western Asia and western America pulsations of climate were probably synchronous, and of the same character.

The latter part of the work is devoted to a consideration of possible causes of climatic pulsations. Four theories are discussed: Croll's theory of the precession of the equinoxes, the theory based on supposed changes in the amount of carbon dioxide in the atmosphere, the theory based on changes in the location, elevation, and extent of the continents, and the theory of solar changes. The author concludes that while each of the four theories may be valid for certain differences in the climates of past time, none save the solar theory is competent to explain the pulsatory changes which he discusses. Evidence in support of the solar theory is then presented and analyzed. The volume closes with a chapter on the climates of past geologic time by Schuchert, in which there is shown an apparent relation between periods of mountain building and periods of cold climate. This suggests the possibility that both the internal forces of the earth and the external atmosphere may be simultaneously affected by changes in the sun.

Huntington's volume does not solve all of the problems presented by a theory of climatic pulsations. It does not pretend to do so. It does aim to show that the evidence thus far available strongly supports the belief that there have been within historic time climatic changes of a pulsatory nature. In this the author has, in the opinion of the reviewer, been successful.

D. W. JOHNSON.

GEOGRAPHIC NOTES ON THE WAR*

By DOUGLAS W. JOHNSON

The Carpathian Campaign. From the geographical point of view the campaign in the Carpathian mountain region is the most interesting of recent military activities. As the manuscript of these notes must be in the hands of the Editor some weeks before they appear in print, it is only possible to discuss the preliminary stages of an action which may be concluded before the reader sees these lines. However, the geographical significance of the features here discussed is none the less real because of this fact, and it will be profitable for us to consider the general situation in the Carpathians as affected by land forms.

When the Russians made their first advance on Cracow, the Carpathian mountains, with their parallel sandstone ridges guarding the northeastern approaches to the irregular central crest of the main range, afforded an effective protection against a flank attack by the Austrians. No serious attempt was made by the Russians to pour large bodies of troops through the passes to overrun the plain of Hungary. They were content to threaten the plains by raiding parties, or to hold the narrow passes against Austrian attacks. Now, however, the conditions are reversed. It is the Austro-German armies which are fighting a defensive warfare and attempting to hold the passes in the face of large Russian forces engaged in a serious campaign to break through the mountain barrier and invade the Hungarian plain.

In both cases the mountainous topography has been a powerful ally of the force on the defensive. At no time during the earlier operations were the Austrians able to get through the passes in sufficient numbers seriously to threaten the Russian flank. Small bodies of Russians, aided by the difficult

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*All of the physiographic features mentioned in this paper are represented on the block diagram facing p. 265 with Professor Johnson's paper in the April *Bulletin*.

nature of the terrain, were able to prevent an Austrian advance into central Galicia. Lately the Russians have found it equally difficult to advance their own armies across the barrier into Hungary. Some conception of the enormous influence of topography upon army movements in this district may be gathered from the fact that although the Russians were painfully making some headway through the mountain ranges prior to the fall of Przemysl, the large reinforcements thrown into their battle line after that event were not sufficient to render possible any great advance.

It is not difficult to understand why the Carpathians present so serious an obstacle to a military offensive. The parallel northwest-southeast trending ridges which constitute the northeastern zone of the middle Carpathians are natural walls of formidable proportions. To cross the intervening valleys and scale such walls in the face of hostile fire involves an attack in numbers greatly superior to that of the defenders, and will usually require the sacrifice of many more men than the defending force will lose. After the Russians had carried several of the ridges, they were held in check for a long time on the Polonina ridge southeast of Cisna, unable to cross the broad valley to the south and capture the main crest of the range between Lupkow and Uzsok passes. Scarcely less difficult for a hostile army is the task of forcing the narrow water gaps, those natural gateways which transverse streams have cut through the parallel ridges. Railroads and good wagon roads are limited in number, and must pass through the water gaps as they converge toward the still smaller number of mountain passes across the main crest. Advancing armies must frequently defile through the gaps, and move in long, slender columns over a single road, exposed for miles to the danger of attack under conditions which would make effective resistance very difficult. The approach to the main passes is thus beset with most serious difficulties for the army which assumes the offensive; and an advance through the passes themselves is impossible until the defending forces have been driven from the adjacent peaks and ridges on either side.

The ease with which a mountain pass may be defended depends on a number of factors, among which we may mention the steepness of the ascent to the pass, the height of the pass above the adjacent country, its breadth and the breadth of the valley or valleys leading up to it, its length from one side of the range to the other, whether or not it is dominated by neighboring peaks and ridges affording easily defended artillery positions, whether or not neighboring roads and subsidiary passes permit parallel columns to cooperate in the attack on the main pass and possibly to turn the position of its defenders by getting in their rear, whether the mountains are forested or open, and the extent to which railroads crossing the passes are built over bridges and through tunnels.

The Dukla Pass is not high above the adjacent country; it is comparatively broad, and the distance between the small towns at either end is not great; a good straight road passes through it on easy grades, but no railroad takes advantage of it. Presumably it was the most easily captured of any of the main passes, and, together with two minor passes on either side, was taken by the Russian troops early in the present campaign.

Twenty miles or more southeast of the Dukla is Lupkow Pass. This is really a double pass, higher than the Dukla and somewhat longer. A railroad connecting Hungary with the fortress of Przemysl crosses the pass by making a big S-shaped double loop, passing through two short tunnels and following high along the side of one mountain ridge for several miles. A good wagon road crosses the main crest by a minor pass three or four miles to the northwest, but must make numerous zig-zags on account of the steepness of the slopes on either side. The country is open or rather thinly forested, and no commanding eminences dominate the pass. It would seem, therefore, that the Lupków Pass, while much more difficult than the Dukla and probably enough higher to have the snow melt out later in the spring, should not present insuperable obstacles to a vigorous offensive. Damage to two short tunnels could be repaired, and the absence of long bridges would make it difficult for the Austrians to render the railroad useless for any great length of time. After securing the Dukla the Russians naturally turned their principal attention to the Lupkow Pass. Whether or not they secured complete control here is not clear, although they certainly reached a more southerly point a short distance farther west.

Forty-five miles farther southeast is the Uzsok Pass. Higher even than the Lupkow and with steeper approaches, it opposed such obstacles to the engineer that only recently was a railroad built across it. Part of the elevation is avoided by a mile-long tunnel at the summit, which if destroyed by the Austrians would render the road useless to the Russians for some time. Moreover, numerous bridges or embankments must be used to span the deep ravines crossed by the railroad, thereby affording additional opportunity for a retreating army to render the line unfit for use. The country about the Uzsok Pass is more densely forested than that farther northwest, and snow lies longer in this pass than in those of lower altitude already discussed. A further obstacle to an attack on the Uzsok lies in the fact that the nature of the northeastern approaches compels a hostile army to defile for several miles along a single road commanded by positions from which the defenders could pour a devastating fire upon advancing columns. We can readily understand, therefore, why the Uzsok Pass has so long resisted repeated attempts of the Russians to capture it. Russian successes at the three main passes over the Carpathians seem to have been inversely proportional to the topographic difficulties encountered.

The mountainous topography, so difficult to overcome during an advance, becomes a serious menace to a retreating army. Lines of communication are few in number, and the seizure of one of these by an enemy may compel the retreat of a large section of the battle front. During the retreat large numbers of troops, supply trains, and artillery are suddenly crowded upon the few roads leading back through the narrow valleys and mountain gateways. Confusion is almost inevitable, and if the enemy captures heights dominating the roads, confusion may easily end in disaster. This danger is so real that even a serious threat against one of its lines of communication may cause an army to withdraw its front to a more secure position.

The temptation to strike at the Russian lines of communication east of Cracow, where they branch off from the Cracow-Jaroslaw lowland and follow the transverse valleys to their heads near the crest of the main range, has been especially great because the battle line makes an abrupt bend not far west of the Dukla Pass, running northward a short distance west of and parallel to the communication lines. To defend these lines the Russians took up their main position on the eastern side of the Dunajec-Biala River trench, utilizing the valley itself as a natural moat in front of the artificial trenches. Evidently the Russians counted confidently on their ability to hold this natural barrier against all assaults, else the difficult passes of the mountains would never have been crossed by Russian troops which were absolutely dependent upon lines of communication passing through difficult mountainous country only a short distance east of the Dunajec-Biala line.

The expected has happened. Austro-German armies have delivered a terrific blow against the Russian position on the Dunajec and Biala Rivers. Unexpectedly, the Russians were driven from their advantageous topographic position. The Dunajec-Biala line was forced, and the Russians compelled to withdraw their advanced troops from the Dukla region and make their next stand on the east side of the flat-bottomed Wisloka Valley, the next topographic barrier which offered significant protection against the pursuing Teutons. Defeated here, their next stand was along the trench of the Wislok. East of that the San River itself is the only important obstacle against pursuit. Fortunately for the Russians, the line of the San, with its broad marshy valley floor and its meandering channel and numerous cut-off lakes, is a far more formidable obstacle than the smaller valleys to the west. Here the Russian Armies may make their final stand with the same success that crowned their defensive tactics behind this barrier last October. The Russians in retreating have repeated the earlier tactics of the Austrians, who utilized each of these transverse valleys as a natural line of defense when being driven westward upon Cracow by the first Russian advance. Because of their strategic value these little known rivers are again figuring prominently in the news despatches.